# CLAIMS

What is claimed is:

1. A robotically controlled medical instrument comprising:

a first jaw;

a second jaw;

a drive mechanism including a linkage having a first end connected by a pivot joint to the first jaw and a second end provided with a pin positioned in a slot of the second jaw, the linkage providing increasing leverage to increase the force applied to an item grasped between the jaws as the pin moves along the slot; and

an electronic controller that controls the operation of the drive mechanism.

2. The medical instrument of claim 1 wherein the slot has a curved segment and a straight segment.

3. The medical instrument of claim 1 wherein the drive mechanism includes a rotation piece connected to the first and second jaws by a second pivot joint, and a second linkage having a first end connected to the first linkage by the pin and a second end provided with a second pin positioned in the slot, rotation of the rotation piece causing a consequent rotation of the first jaw with respect to the second jaw, the first and second pins moving along the slot as the rotation piece rotates.

4. The medical instrument of claim 3 wherein the rotation piece is connected to a first drive cable, and the second jaw is connected to a second drive cable, respective tension being applied to the first and second drive cables to operate the one or both jaws.

5. The medical instrument of claim 4 further comprising a shaft, the first and second jaws being supported at the distal end of the shaft, and the first and second drive cables extending through the shaft.

6. The medical instrument of claim 1 further comprising an accommodating mechanism that allows continued movement of the drive mechanism towards a locked position even after the jaws contact a larger item so that the drive mechanism can move to the locked position when grasping items of different sizes.

7. The medical instrument of claim 6 wherein the accommodating mechanism is an extended end segment of the slot extending from the straight segment, the pin residing in the end segment when the jaws grasp an item, the extent to which being dependent upon the size of the item being grasped.

8. The medical instrument of claim 6 wherein the accommodating mechanism is a compliance member.

9. The medical instrument of claim 8 wherein the compliance member is resilient member interposed between the linkage and the first jaw, the resilient member being compressed when the jaws grasp an item, the extent of the compression of the resilient member being dependent on the size of the item being grasped.

10. The medical instrument of claim 8 wherein the compliance member is a hinge in one of the jaws about which the respective jaw flexes, the amount of flexing being dependent upon the size of an item being grasped.

11. The medical instrument of claim 10 wherein the hinge is located below the furthest extent of a gap that extends into the respective jaw.

12. A robotically controlled medical instrument comprising:

a first jaw;

a second jaw;

a drive mechanism which increases the force applied to an item grasped between the jaws,

the drive mechanism and the jaws being provided with an accommodating mechanism that allows continued movement of the drive mechanism towards a locked position even after the jaws contact a larger item so that the drive mechanism can move to the locked position when grasping items of different sizes; and

an electronic controller that controls the operation of the drive mechanism.

13. The medical instrument of claim 12 wherein the first jaw is coupled to a first drive cable, and the second jaw is coupled to a second drive cable, respective tension being applied to the first and second drive cables to operate the first and second jaws.

14. The medical instrument of claim 13 wherein the amount of tension being applied to the respective cables is controlled with the controller coupled with a user interface operated by a user.

15. The medical instrument of claim 12 wherein the accommodating mechanism is a compliance member.

16. The medical instrument of claim 15 wherein the drive member increases leverage through a linkage connected to the first jaw by a pivot joint, the compliance member being a resilient member interposed between the linkage and the first jaw, and being compressed when the jaws grasp an item, the extent of the compression of the resilient member being dependent on the size of the item being grasped.

17. The medical instrument of claim 15 wherein the compliance member is a hinge in one of the jaws about which the respective jaw flexes, the amount of flexing being dependent upon the size of an item being grasped.

18. The medical instrument of claim 17 wherein the hinge is located below the furthest extent of a gap that extends into the respective jaw.

19. The medical instrument of claim 12 wherein the drive mechanism includes a linkage having a first end connected by a pivot joint to the first jaw and a second end provided with a pin positioned in a slot of the second jaw, the slot having a curved segment, a straight segment extending from the curved segment, and an extended end segment extending from the straight segment, the accommodating mechanism being the end segment, the pin residing in the end segment when the jaws grasp an item, the extent to which being dependent upon the size of the item being grasped.

20. A method of grasping an item with a robotically controlled surgical tool comprising:

positioning the item between a first jaw and a second jaw of the tool;

moving the first and second jaws to grasp the item; and

increasing leverage to the jaws to increase the force applied to the item grasped between the jaws.

21. The method of claim 20 further comprising operating the first and second jaws with a first drive cable and a second drive cable coupled to the first and second jaws, respectively.

22. The method of claim 21 wherein the operating the first and second jaws with the first and second drive cables includes applying respective tension to the first and second drive cables.

23. The method of claim 22 further comprising controlling the tension in the cables with a controller coupled with a user interface operated by a user, the user providing operating instructions through the user interface to operate the surgical tool.

24. A method of grasping an item with a robotically controlled surgical tool comprising:

positioning the item between a first jaw and a second jaw of the tool;

moving the first and second jaws to a contact position to grasp the item;

increasing the force applied to the item grasped between the jaws, the force being applied to the grasped item as the jaws close to a locked position; and

allowing a closing force to be applied to the grasped item corresponding to the size of the item being grasped.

25. The method of claim 24 further comprising operating the first and second jaws with a first drive cable and a second drive cable coupled to the first and second jaws, respectively.

26. The method of claim 25 wherein the operating the first and second jaws includes applying respective tension to the first and second drive cables.

27. The method of claim 26 further comprising controlling the tension in the cables with a controller coupled with a user interface operated by a user, the user providing operating instructions through the user interface to operate the surgical tool.

28. A medical instrument comprising:

a grasping means grasping an item;

a driving means which increases the force applied to an item grasped between the grasping means,

the driving means and the grasping means being provided with an accommodating means that allows continued movement of the driving means towards a locked position even after the grasping means contact a larger item so that the driving means can move to the locked position when the grasping means grasps items of different sizes.

29. A robotically controlled medical instrument comprising:

an instrument shaft having proximal and distal ends;

a tool supported from the distal end of said instrument shaft and useable in performing a medical procedure on a subject;

said tool constructed and arranged so to be capable of receiving different size items and including a pair of work members, a drive mechanism which increases the force applied to an item grasped between the work members, and an accommodating mechanism interacting with said drive mechanism and work members and that allows the work members to be closed beyond a maximum grasping position so that the work members can grasp items of various size; and

a robotic controller coupled to said instrument shaft for remotely effecting control of said tool.

30. The medical instrument of claim 29 further including a rotation piece coupling with one of said work members and a pair of linkages one engaged with the rotating piece, and the other engaged with one of said work members, said linkages also pivotally supported relative to each other.

31. The medical instrument of claim 30 including at least one drive cable extending via said instrument shaft for operating the rotating piece, and the other for operating the other work member.

32. The medical instrument of claim 29 wherein the accommodating mechanism comprises a compliance member.

33. The medical instrument of claim 32 wherein said the drive mechanism increases leverage through a linkage connected to the first jaw by a pivot joint, the compliance member being a resilient member interposed between the linkage and the first jaw, and being compressed when the jaws grasp an item, the extent

of the compression of the resilient member being dependent on the size of the item being grasped.

34. The medical instrument of claim 32 wherein the compliance member is a hinge in one of the work members about which the respective work member flexes, the amount of flexing being dependent upon the size of an item being grasped.

35. The medical instrument of claim 29 wherein the drive mechanism includes a linkage having a first end connected by a pivot joint to the first work member and a second end provided with a pin positioned in a slot of the second work member, the slot having a curved segment, a straight segment extending from the curved segment, and an extended end segment extending from the straight segment, the accommodating mechanism being the end segment, the pin residing in the end segment when the work members grasp an item, the extent to which being dependent upon the size of the item being grasped.

36. The medical instrument of claim 29 wherein the force applied by the work members beyond the maximum grasping position is proportional to the size of the item being grasped.

37. A method of grasping an item with a robotically controlled surgical tool comprising:

positioning the item between a first jaw and a second jaw of the tool;

moving the first and second jaws to an initial contact position for grasping the item; and

increasing leverage to the jaws beyond the initial contact position to increase the force applied to the item grasped between the jaws with the

magnitude of applied force being proportional to the size of the item being grasped.

38. The method of claim 37 wherein the applied force is directly proportional to the diameter of the item being grasped.

39. The method of claim 37 wherein the proportional force is applied with the use of a resilient member associated with the jaws.

40. The method of claim 37 wherein the proportional force is applied with the use of at least one jaw having a closable gap.

41. The method of claim 37 wherein the tool includes a drive mechanism, and wherein the drive mechanism includes a linkage having a first end connected by a pivot joint to the first jaw and a second end provided with a pin positioned in a slot of the second jaw, the slot having a curved segment, a straight segment extending from the curved segment, and an extended end segment extending from the straight segment that provides an accommodating mechanism, the pin residing in the end segment when the jaws grasp an item, the extent to which being dependent upon the size of the item being grasped.

42. A method of grasping an item with a surgical tool comprising:

positioning the item between a first jaw and a second jaw of the tool;

moving the first and second jaws to a contact position to grasp the item;

increasing the force applied to the item grasped between the jaws, the force being applied to the grasped item as the jaws close to a locked position; and

providing a force at the locked position that is proportional to the size of the item being grasped.

43. The method of claim 42 including controlling the applied force via a remote user interface, coupled to the tool via an electrical controller.

44. A method of performing a medical procedure on a patient, said method comprising:

inserting an instrument shaft, which supports at its distal end an end effector, through an entry location in the patient's body to a location where the end effector is at an operative site within the patient's body while the proximal end of the instrument shaft is positioned outside the patient's body;

coupling the instrument shaft to a robotically controlled system;

moving the end effector, by means of the robotically controlled system, to an initial contact position for grasping an item; and

increasing leverage to the end effector beyond the initial contact position to increase the force applied to the item grasped by the end effector with the magnitude of the applied force, after initial contact being proportional to the size of the item being grasped.

45. A medical instrument comprising:

a first jaw;

a second jaw;

a base from which the first and second jaws can be supported;

a pivot for at least one of said jaws;

wherein said pivot is spaced from a center axis of said base to provide enhanced gripping; and

a slide mechanism in said base for controlled pivoting of said at least one jaw about said pivot.

46. The medical instrument of claim 45 including a second pivot for said second jaw.

47. The medical instrument of claim 46 wherein said jaws each have elongated slots, and said slide mechanism has a pin that extends through said slots.

48. The medical instrument of claim 47 wherein said base has side legs that retain the slide mechanism therebetween.

49. The medical instrument of claim 48 wherein said legs also have elongated slots for receiving said pin.

50. The medical instrument of claim 45 including a second pivot for said second jaw, with said first and second pivots being separated from each other and disposed on opposite sides of said center axis.

51. The medical instrument of claim 45 wherein said at least one jaw has spaced legs that are each slotted, and said slide mechanism has a pin that engages the slots in both legs.

52. The medical instrument of claim 45 including a single tendon for controlling said slide member.

53. The medical instrument of claim 52 wherein said single tendon is controlled remotely from an electrical controller.

54. The medical instrument of claim 53 including a user interface having an input device at which a medical practitioner can control the tendon via the electrical controller.

55. A robotically controlled medical instrument end effector construction comprising:

a first jaw;

a second jaw;

a first pivot for intercoupling said first and second jaws to enable opening and closing thereof; and

a gear member for engaging respective proximal ends of said first and second jaws, supported at a second pivot separate from the first pivot and controlled remotely from a user interface.

56. The construction of claim 55 wherein each jaw has at its proximal end a gear rack that engages with separate portions of said gear member.

57. The construction of claim 56 wherein said gear member comprises a pair of circular gears supported on opposite sides of a center plate, with one gear rack engaging one of said circular gears and the other gear rack engaging the other of said circular gears.

58. The construction of claim 57 wherein one gear rack has outwardly facing teeth and the other gear rack has inwardly facing teeth.

59. The construction of claim 58 including a base housing for the jaws and gear member.

60. The construction of claim 59 including a cable drive connected to said gear member.

61. The construction of claim 55 including a cable drive connected to said gear member for controlling the rotation thereof and the attendant opening and closing of the jaws.

62. A robotically controlled medical instrument end effector construction comprising:

a first jaw;

a second jaw;

a first pivot for intercoupling said first and second jaws to enable opening and closing thereof; and

a drive mechanism which increases the force applied to an item grasped between the jaws as it is rotated;

said drive mechanism comprising a control wheel engaging respective proximal ends of said first and second jaws, supported at a second pivot separate from the first pivot and controlled remotely from a user interface.

63. The construction of claim 62 wherein each jaw has at its proximal end a slot that engages with separate pins of said control wheel.

64. The construction of claim 63 wherein the pins of said control wheel are faced in opposite directions to engage slots of the jaws that are disposed on opposite sides of the control wheel.

65. The construction of claim 64 including a base housing for the jaws and control wheel.

66. The construction of claim 65 including a cable drive connected to said control wheel.

67. The construction of claim 62 including a cable drive connected to said drive mechanism for controlling the rotation thereof and the attendant opening and closing of the jaws.

68. A medical instrument end effector for telerobotic control from a remote location, comprising:

a first work member;

a second work member;

a first pivot for intercoupling said first and second work members to enable opening and closing thereof; and

a drive mechanism which increases the force applied to an item grasped between the work members as it is rotated;

said drive mechanism comprising a rotatable member engaging respective proximal ends of said first and second work members, supported at a second pivot separate from the first pivot and controlled remotely from a user interface.

69. The end effector of claim 68 wherein said rotatable member comprises a control wheel, and each work member has at its proximal end a slot that engages with separate pins of said gear member.

70. The end effector of claim 69 wherein the pins of said control wheel are faced in opposite directions to engage slots of the work members that are disposed on opposite sides of the control wheel.

71. The end effector of claim 68 wherein said rotatable member comprises a gear member that comprises a pair of circular gears supported on opposite sides of a center plate, and wherein each work member has at its proximal end a gear rack that engages with said respective pair of circular gears.

72. The end effector of claim 71 including a cable drive to said rotatable member controlled in a pull-pull manner.